MEMORANDUM

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Subject: Supplemental Visibility Assessment for Vineyard Wind during Construction

INTRODUCTION

This memo responds to EPA's request to provide supplemental information regarding the potential for the Vineyard Wind offshore wind project's (Project) temporary construction emissions to affect visibility at Class I areas and demonstrates that air emissions associated with construction of the Project will not cause or contribute to an adverse impact on any air quality related values (AQRV) at any Class I area. This supplemental information is being provided after EPA conducted a Q/D analysis of the Project which assumed that all emissions from construction of the Project would come from a single source. Discussion subsequent to this Q/D analysis raised the question of the appropriateness of this initial screening approach for the Project. This memo describes why the results of that initial Q/D screening are not relevant or appropriate to this particular Project. It further provides information for the federal land manager (FLM) to make a determination, without need for further modeling analysis of the Project, that the Project will not have adverse impacts on air quality to the nearest Class 1 areas to the Project.

This analysis focuses on the closest Class I area to the offshore construction area (referred to as the WDA), Lye Brook Wilderness, which is over 300 kilometers from the nearest offshore construction point. Being the closest Class 1 area to the Project, and also being located in the vicinity of the other nearest Class 1 areas, an analysis of Lye Brook provides a "worst-case" or very conservative analysis.

Specifically, this memo demonstrates that Project construction emissions will not affect visibility in the Lye Brook Class I Area during construction and therefore no further analysis is necessary. This memo:

- Explains how the standard Q/D screening analysis is not an appropriate screening tool for application to short-term emissions spread over a wide area;
- Demonstrates that the nearest regulated emissions sources are located over 300 kilometers (km) from the Lye Brook Class I area, and describes the precedent for disregarding sources over 300 km from a Class 1 area;
- Documents that the prevailing wind direction in the project area is away from the Lye Brook Class I area. Less than 3% of the time (11 days in a year) Project construction emissions may potentially disperse towards the Lye Brook Class I area, and even this statistic makes the conservative assumption that the prevailing wind at the Project site continues in the same direction for the entire >300 km to the Class 1 area for the length of time it would take emissions to be carried to the Class 1 area;
- Discusses the level of conservatism in the emission estimates, both in how the total tons of emissions were determined and in the number of sources subject to OCS Air Permitting;
- Describes how the offshore wind project, once operational is likely to have a positive impact, not an adverse impact, on Air Quality Related Values (AQRV) at the Lye Brook Class I area; and
- Presents a VISCREEN analysis showing that highest emitting scenario will comply with the criteria established for maximum visual impacts at the Lye Brook Class I area.

BACKGROUND

Vineyard Wind is well underway in developing the nation's first large-scale offshore wind energy project located over 30 miles from the mainland coast of Massachusetts. The Project will generate clean, renewable, cost-competitive energy for over 400,000 homes and businesses across the Commonwealth, while reducing carbon emissions by over 1.6 million tons per year.[1]

Under the Clean Air Act, "any equipment, activity, or facility" that "(i) emits or has the potential to emit any air pollutant, (ii) is regulated or authorized under the Outer Continental Shelf Lands Act, and (iii) is located on the Outer Continental Shelf or in or on waters above the Outer Continental Shelf," is an OCS source regulated by the EPA's OCS Air Regulations. In addition, "emissions from any vessel servicing or associated with an OCS source, including emissions while at the OCS source or en route to or from the OCS source within 25 miles of the OCS source, shall be considered direct emissions from the OCS source." 42 U.S.C. § 7627(a)(4)(C). During construction, Project OCS sources may include diesel generators used to supply power to the Wind Turbine Generators (WTGs) and Electrical Service Platforms (ESPs) during commissioning, and

[1] https://www.vineyardwind.com/the-project

compression-ignition engines on jack-up vessels (while their legs are attached to the seafloor), anchored vessels, and vessels that are tethered to an OCS source[2].

In accordance with the Clean Air Act and its implementing regulations, Vineyard Wind submitted an OCS Air Permit application to EPA in August 2018, including an air quality modeling protocol. In November 2018 Vineyard Wind submitted an air quality analysis for construction activities and an air quality modeling report for operation & maintenance emissions. The analysis of construction activities found that criteria air pollutants were below significant impact levels at Class I areas, and the O&M air modeling report said that air pollutants were below National Ambient Air Quality Standards at public receptors. On January 29th, 2019, EPA determined that the OCS Air Permit application was complete.

Federal Land Managers (FLMs) have visibility and air pollution protection responsibilities at Class I areas. Section 165 of the Clean Air Act requires EPA, or the local permitting authority, to notify the FLM if emissions from a proposed project may impact a Class I area. As explained in EPA guidance letters, notification to the FLM occurs for "facilities that will be located within 100 km of a Class I area" and "large sources located at distances greater than 100 km if there is reason to believe that such sources could affect the air quality in the Class I area."[3] As shown in this memo, there is no reason to believe that temporary construction emissions spread over a large area fourteen miles out to sea could affect onshore air quality at Lye Brook Wilderness, which is over 300 kilometers away and generally not in the direction of the wind at the Project site for 97% of the time. .

DIRECT APPLICATION OF THE Q/D SCREENING ANALYSIS IS NOT APPROPRIATE

As described in the 2010 FLAG Federal Report, for sources located greater than 50 km from a Class I Area the FLM has adopted a size (Q)/distance (D) criteria, (a "Q/D") to determine whether further AQRV review is necessary. If the Q/D ratio is less than 10, it is assumed that there would be no affects and therefore additional analysis is not required. The "Q" portion of the "Q/D" analysis is the sum of Sulfur Dioxide (SO_2), Oxides of Nitrogen (NO_x), Particulate Matter (PM_{10}) and Sulfuric Acid (H_2SO_4) in tons per year based on a 24-hour maximum allowable emissions.

The 2010 FLAG Q/D Guidance was developed to provide consistency in project reviews and notification for new or modified land-based sources. Accordingly, it assumes that project emissions occur from a single location and that emissions are continuous (i.e., "tons per year" for continuous

[2] As described in the November 2018 air quality analysis of construction activities, the offshore export cable corridor may use anchored vessels that could be considered OCS sources, but these potential emissions are significantly lower than offshore construction emissions, would occur over a short period of days, and could not reasonably be expected to affect a Class I area. Therefore, this memo focuses on construction emissions in the wind development area.

[3] Letter from A. Wood, EPA Air Quality Policy Division to C McCoy, National Park Service, 1/11/2017

source operation). Its basic assumptions are not applicable to the Vineyard Wind project where temporary construction related emissions from multiple sources occur over a large area (675 square kilometers). Vineyard Wind's construction emissions occur at different WTG and ESP locations at different times and each are kilometers apart within the WDA. As a result, emissions are already dispersed over a wide area with prevailing winds directing emissions away from the Class I areas. For these reasons, the Q/D screening tool is not an appropriate fit for this project and should not be looked to in determining whether additional AQRV analysis is necessary. Rather, the EPA and FLM should consider the factors discussed below to conclude that no further analysis is necessary.

Furthermore, even if the Q/D analysis were applied to this Project, given the highly dispersed nature of the various sources, the analysis should be applied to each source (i.e. one turbine or one ESP) on its own, as opposed to assuming that all emissions are coming from one particular source. Such an analysis would show that each of the sources had a Q/D ratio of far less than 10, if not less than 1.0.

DISTANCE TO NEAREST CLASS I AREA EXCEEDS 300 KM

As shown in the attached Figure 1 and Figure 2, the closest WTG and ESP are located over 300 km away from the following Class I areas:

- Lye Brook Wilderness area is 301 km from the closest WTG or ESP location;
- Presidential Range-Dry River Wilderness area is 335 km from the closest WTG or ESP location; and
- Brigantine Wilderness Area is greater than 350 km the closest WTG or ESP location.

Guidance suggests that air quality impacts occurring greater than 300 km from a Class I area are generally not evaluated.[4] This has generally been the case because the prevailing model used for Visibility analyses in Class I areas, CALPUFF, tends to over-predict maximum concentrations at distances beyond 300 km [5]. Thus, as there is no model capable of modeling reliably beyond 300 km, in practice, the FLMs have limited their review to projects occurring within 300 km of a Class I area.

[4] https://www.fws.gov/refuges/airquality/docs/Brigantine_WA.pdf
[5] https://www3.epa.gov/scram001/7thconf/calpuff/phase2.pdf, at page D-12.

WIND DIRECTION IS AWAY FROM LYE BROOK WILDERNESS

In order for the Project construction emissions to potentially impact a Class I area, the prevailing winds must be in the direction of the Class I area. Therefore, the frequency of the wind direction in the WDA was examined using meteorological data collected near the WDA.

The closest construction emissions occur approximately 23 km from any shore. As part of the air dispersion modeling performed for the Project, the meteorological conditions were assessed at two locations. The first is the nearest on-shore meteorological weather station located on Martha's Vineyard which is located 43.4 km from the center of the WDA. The second is a set of overwater meteorological conditions as measured by several meteorological buoys in the vicinity of the WDA. For the air dispersion modeling, five years of meteorological data was obtained and analyzed. Each of these sets of meteorological data measure wind direction and wind speed, each set of data was plotted using wind roses.

Wind roses are used to plot wind speed and wind direction and depict the direction of the wind over time. The wind rose for the on-shore weather station on Martha's Vineyard is shown in Figure 3. The wind rose for the overwater weather observations appears in Figure 4. Both figures demonstrate that the prevailing winds are out of the west – that is, away from the Lye Brook Class I area, which is located to the north of the WDA. The wind roses further demonstrate that project emissions could potentially only be dispersed towards the Lye Brook Class I area less than 3% of the time (or approximately 11 days per year). And to assume that even this small amount of time there would be an impact on air quality at Lye Brook makes the conservative assumption that the prevailing wind at the Project site continues in the same direction for the entire >300 km to the Class 1 area for the length of time it would take emissions to be carried to the Class 1 area.

Given that the closest project emissions are over 300 km from the Lye Brook Class I area and that the prevailing wind direction is away from the Class I areas, it is reasonable to conclude without further analysis that project construction emissions would not affect the air quality at the Lye Brook Class I area.

PROJECT EMISSIONS ESTIMATES ARE CONSERVATIVE

As described in the OCS Air Permit application, the Project's air emissions are mostly from internal combustion engines used to power vessels or equipment on vessels during the construction, operation, and maintenance of the Project's offshore facilities. Vineyard Wind's OCS permit application provides overly conservative estimates of the potential project emissions for the following reasons:

- Vineyard Wind filed its application well in advance of procuring the vessels and equipment that will be used during construction and therefore overestimated emissions to account for uncertainties.

- The project is being permitted using an "envelope" concept to provide flexibility to refine final design, installation, and operations and maintenance logistics during environmental and permitting review. For purposes or the envelope, it was assumed that 100, 8 MW wind turbine generators (WTGs) would be installed. However, through the selection of a 9.5 MW WTG, only 84 WTGS will actually be installed. Nevertheless, emissions estimates remain the same under the 100 WTG envelope concept.

- For all modelling purposes, Vineyard Wind has used the most likely yet conservative scenario, and generally choosing the scenario with more and larger air emissions sources where multiple likely scenarios exist. Additionally, Vineyard Wind has used representative source parameters (exit velocity, stack diameter, stack exit temperature) for the types of ships that may be used for the planned activities.

- In estimating emissions, Vineyard Wind conservatively assumed that the majority of vessels used during construction would be servicing or associated with an OCS source thus characterizing them as direct emissions from the OCS source rather than mobile source emissions that would not be considered in the analysis.

The conservative assumptions and approach taken to estimate emissions results in an overestimate of actual project construction emissions. This overestimation must be taken into account when evaluating the project's potential impact on the Lye Brook Wilderness area.

THE PROJECT CAN IMPROVE AIR QUALITY RELATED VALUES

The Federal Land Managers Air Quality Related Values Work Group (FLAG) Guidance provides that impact determinations are "made on a case-by-case basis for each area taking into account existing air quality conditions." Per the Forest Service information on the Lye Brook Wilderness Area[6], "regional haze has decreased annually at Lye Brook Wilderness at a rate of approximately 3% per year" and "fine ammonium sulfate particles account for the largest contribution to visibility impairment." As described in Section 2.2.1 of Vineyard Wind's air permit application, electricity generated by the WTGs is emission-free and will displace electricity generated by fossil fuel-powered plants, thereby significantly reducing emissions from the power grid over the lifespan of the Project. The Project is expected to reduce nitrogen oxide ("NO_x") and sulfur dioxides ("SO_2") emissions by approximately 1,050 tpy and 860 tpy, respectively. This will reduce the development of fine ammonium sulfate particles in the atmosphere, which is likely to reduce visibility impairment at the Lye Brook Wilderness Area and elsewhere. Thus, rather than adversely affecting Class I areas, the project over time will help improve air quality related values in these areas.

[6] https://webcam.srs.fs.fed.us/psd/lyebrook/

VISCREEN ANALYSIS

A visibility analysis of the proposed Project was conducted using the EPA VISCREEN program (version 1.01 dated 88341). The VISCREEN model (EPA, 1992) provides the capability of assessing plume contrast (Cp) and plume perceptibility (Delta E) against two backgrounds: sky and terrain.

Visibility impacts are a function of particulate and NO_2 emissions. Particles are capable of either scattering or absorbing light while NO_2 absorbs light. It should be noted that NO_2 absorbs more light in the blue end of the spectrum. These constituents can either increase or decrease the light intensity (or contrast) of the plume against its background. VISCREEN plume contrast calculations are performed at three wavelengths within the visible spectrum (blue, green, and red). Plume perceptibility as determined by VISCREEN is determined from plume contrast at all visible wavelengths and "is a function of changes in both brightness and color" (EPA, 1992).

The VISCREEN model provides three levels of analysis; Level 1, Level 2, and Level 3. The first two Levels are screening approaches. If the Project fails a Level-1 screening analysis, then more refined modeling must be conducted.

The perceptibility of a distinct plume depends on the plume contrast at all visible wavelengths. Perceptibility is a function of changes in both brightness and color. The color difference parameter, ΔE, was developed to specify the perceived magnitude of changes in color and brightness and is used as the primary basis for assessing perceptibility of plume visual impacts in the screening analysis. Plume contrast results from an increase or decrease in light transmitted from the viewing background through the plume to the observer. This increase or decrease in light intensity is caused by plume constituents that scatter and/or absorb light. The first criterion is a ΔE value of 2.0; the second is a contrast value of 0.05 (EPA 1992).

A Level 1 VISCREEN analysis was performed on the nearest Class I area; Lye Brook Wilderness Area. Level 1 Screening in the VISCREEN model is designed to provide a conservative estimate of visual impacts from the plume. This conservatism is achieved by assuming worst-case meteorological conditions: extremely stable (F) atmospheric conditions, coupled with a very low wind speed (1 meter per second [m/s]) persisting for 12 hours, with a wind that would transport the plume directly adjacent to the observer. The observer is located at the closest location of the Class I area to the proposed source per VISCREEN guidance (EPA 1992); in this case, it is the east area of the Lye Brook Wilderness Area.

To be conservative, the total tons per year during the peak period of construction were input into the VISCREEN model. The minimum and maximum distances from the closest point in the WDA[7] to the Lye Brook Wilderness Area were input. A default background visual range of 194.8 km was used (U.S. Department of Interior, 2010). Table 1 presents results of the VISCREEN modeling analysis completed for the Vineyard Wind project during construction.

The VISCREEN modeling demonstrates that the highest emitting scenario will comply with the criteria established in the Workbook for Plume Visual Impact Screening and Analysis (Revised) (EPA 1992) for maximum visual impacts inside the Lye Brook Wilderness Area.

Table 1 Class I Visibility Modeling Results -Maximum Visual Impacts Inside the Class I Area

					Delta-E		Absolute Contrast	
Background	Theta (°)	Azimuth (°)	Distance (km)	Alpha (°)	Screening Criteria	Plume	Screening Criteria	Plume
SKY	10	84	299.8	84	2	0.180	0.05	-0.001
SKY	140	84	299.8	84	2	0.103	0.05	-0.003
TERRAIN	10	84	299.8	84	2	0.049	0.05	0.001
TERRAIN	140	84	299.8	84	2	0.018	0.05	0.001

CONCLUSIONS

This supplemental filing documents that the air emissions associated with construction of the Vineyard Wind project will not cause or contribute to an adverse impact on any AQRV at any Class I area. Construction activities associated with the project occur almost exclusively 300 km or more away from the nearest Class I area and winds rarely (fewer than 11 days per year) blow in the direction towards the nearest Class I area. Construction emissions are temporary, spread out over a large area, and likely to be lower than currently estimated. The VISCREEN analysis documents that visual screening criteria are not exceeded. During operation, the project will help reduce emissions regionally, resulting in an expected improvement to AQRV at the nearest Class 1 areas.

There are multiple reasons why construction of the Vineyard Wind Project will not negatively affect air quality in any Class 1 area, and reason to believe the Project may actually improve air quality in the nearest Class 1 areas. This memo provides substantial information by which the FLM can determine there will be no impacts to any Class 1 area, and can conclude that no further analysis of AQRV is needed.

[7] Consistent with the August 2018 modeling protocol approved by EPA, the closest point of the WDA, which is the edge of the lease area boundary, was used for the VISCREEN analysis. However, the closest source is 301 km from Lye Brook Wilderness Area.

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Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division

Vineyard Wind Project

VINEYARD WIND

Figure 1

Class 1 Areas

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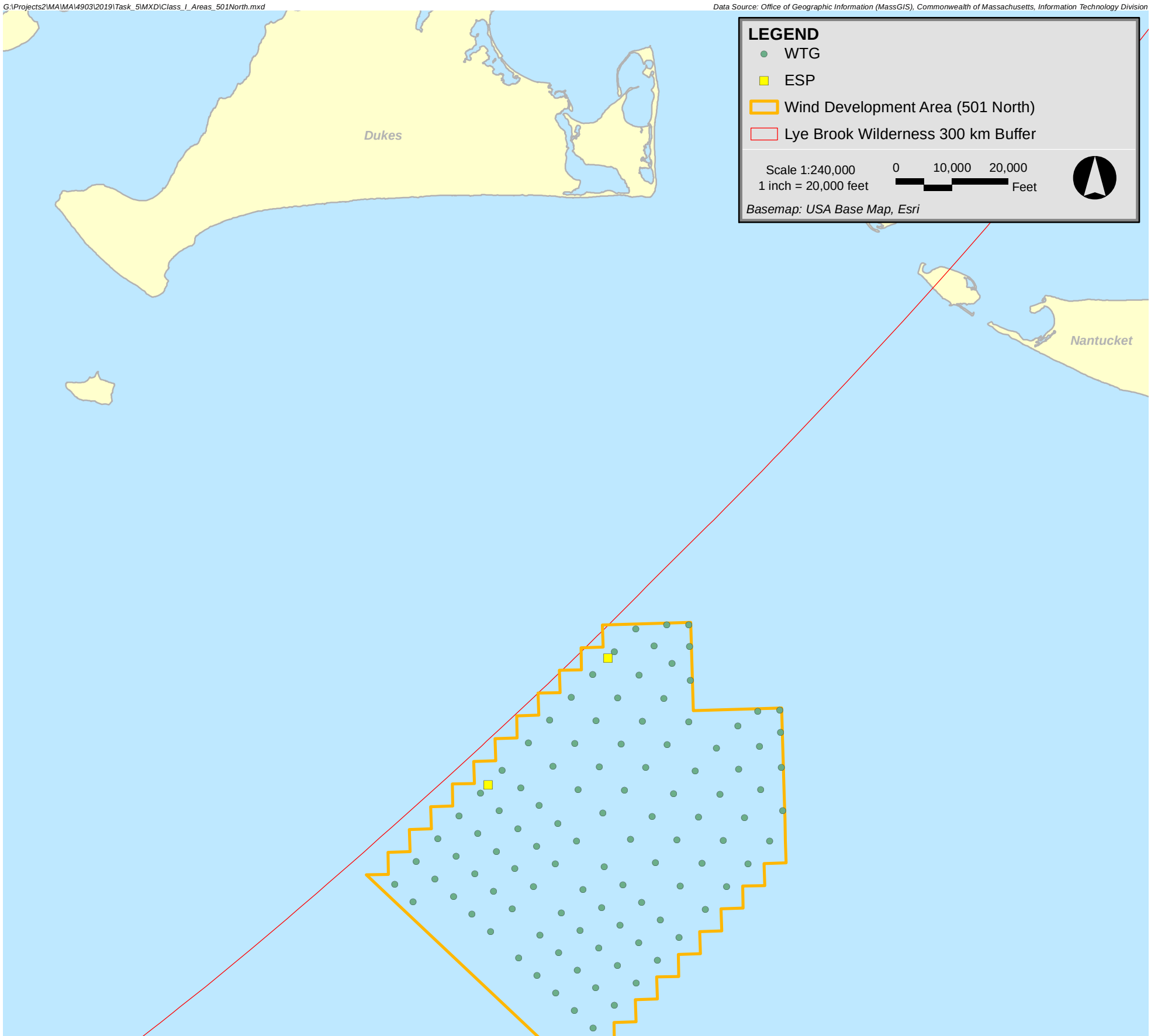
Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Vineyard Wind Project

VINEYARD WIND

Figure 2

Class 1 Areas

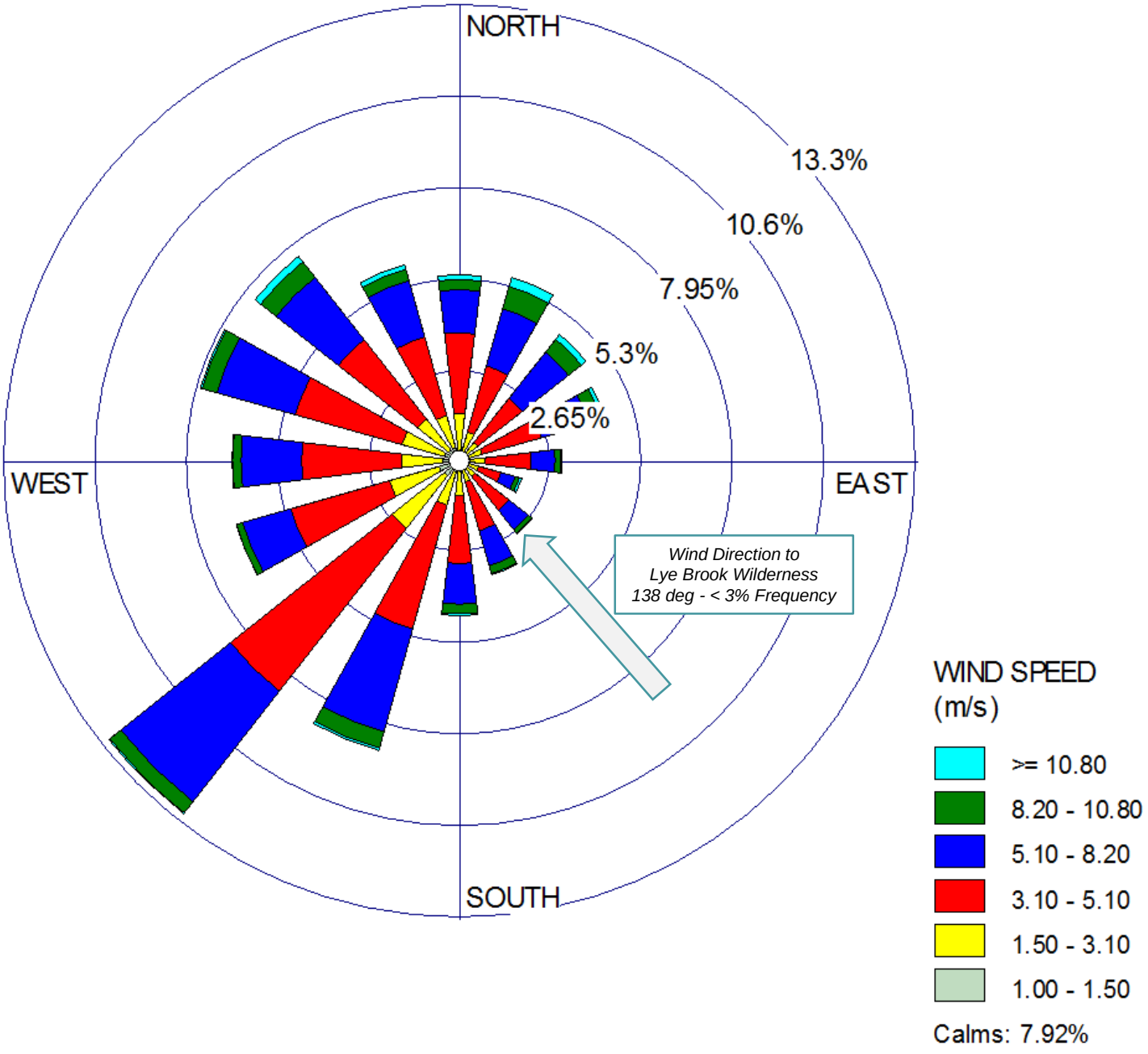


Figure 3

5-year (2013-2017) Wind Rose of Measurements from the Vineyard Haven Airport NWS Station

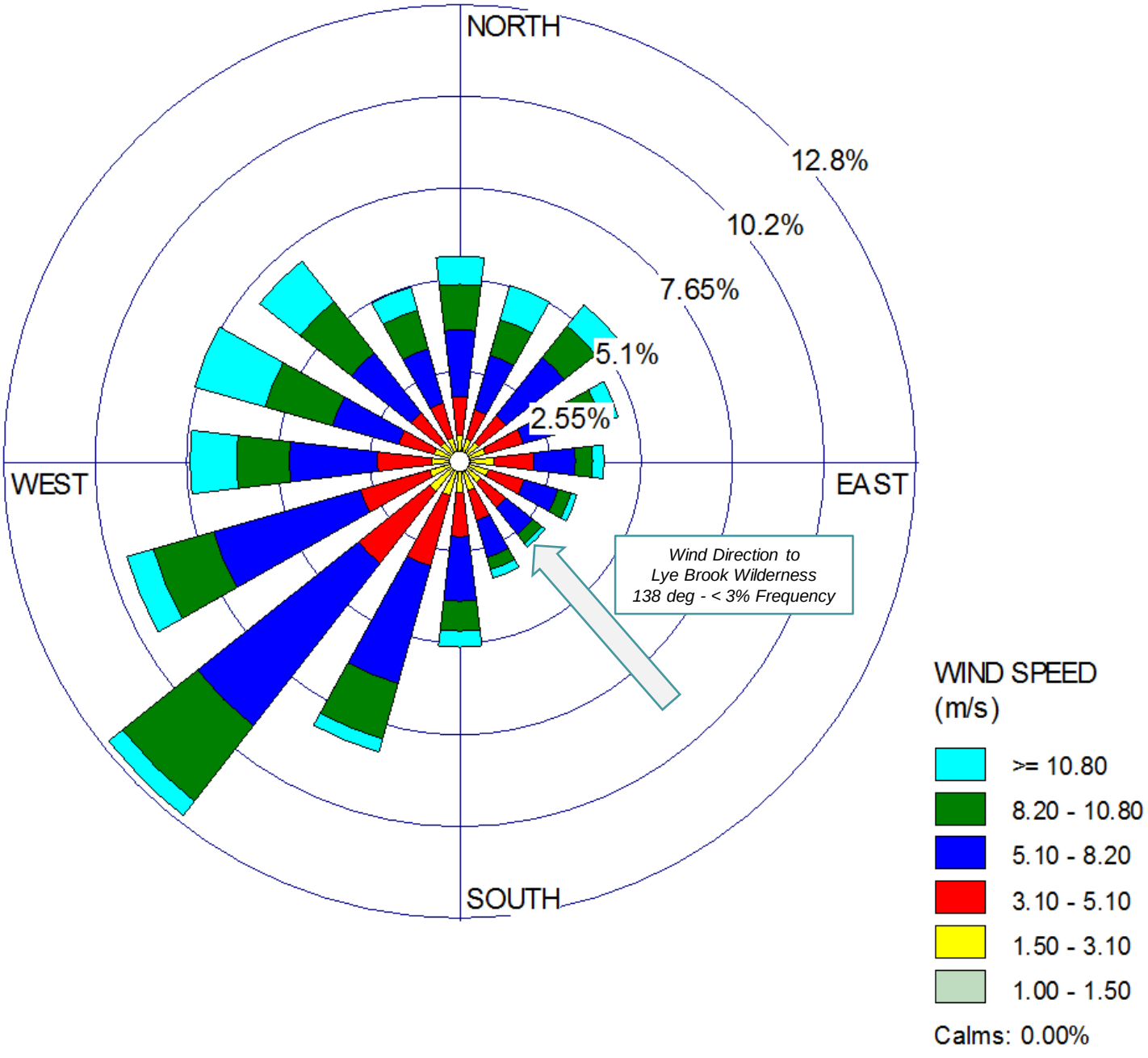


Figure 4

5-year (2013-2017) Wind Rose of Measurements from the Offshore Meteorological File